

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank) 2. REPORT DATE 3. REPORT TYPE AND DATES COVERED
FINAL REPORT 01 Oct 93 - 30 Sep 95

4. TITLE AND SUBTITLE
Development of 1-2 um Tunable Solid-State Lasers
Based on Cr⁴⁺ as a Lasing Ion 5. FUNDING NUMBERS

6. AUTHOR(S)
Professor Robert R. Alfano 4276/AS
62228D

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
City College of the City University of New York
Convent Avenue & 138th Street
New York, NY 10031 8. PERFORMING ORGANIZATION
REPORT NUMBER
AFOSR-TR-96
0109

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NE
110 Duncan Avenue Suite B115
Bolling AFB DC 20332-0001 F49620-93-1-0595

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED 12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
Several laser systems were acquired using the funds under the AFOSR Research Instrumentation Program. The following laser systems were purchased:
1. 20-W continuous-wave mode-locked Antares Nd:YAG laser from Coherent.
2. Cr:forsterite regenerative amplifier, pulse stretcher, and pulse compressor were custom built by Excel/Quantronix. The regenerative amplifier is pumped by a Excel/Quantronix 20-W 1-kHz Q-switched Nd:YAG laser.
3. Four high-brightness 1-W 970-nm Spectra Diode Laser semiconductor diode lasers.

14. SUBJECT TERMS 15. NUMBER OF PAGES
16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED
18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED
19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED
20. LIMITATION OF ABSTRACT

19960320 046

DEVELOPMENT OF 1 - 2 μm TUNABLE SOLID-STATE LASERS BASED ON Cr^{4+} AS A LASING ION

RESEARCH INSTRUMENTATION

Air Force Office of Scientific Research

Contract/Grant Number: F49620-93-1-0595

FINAL REPORT

Several laser systems were acquired using the funds under the AFOSR Research Instrumentation Program. The following laser systems were purchased:

1. 20-W continuous-wave mode-locked Antares Nd:YAG laser from Coherent.
2. Cr:forsterite regenerative amplifier, pulse stretcher, and pulse compressor were custom built by Excel/Quantronix. The regenerative amplifier is pumped by a Excel/Quantronix 20-W 1-kHz Q-switched Nd:YAG laser.
3. Four high-brightness 1-W 970-nm Spectra Diode Laser semiconductor diode lasers.

Laser systems acquired under the Research Instrumentation Program were used (and will be used in the future) to build novel types of tunable solid-state laser systems for the 1130 - 1600 nm spectral region. The laser systems under construction are using Cr:forsterite and Cr:YAG laser crystals.

The major task in the development of chromium-doped forsterite lasers was generation and amplification of femtosecond pulses in the 1200 - 1300 nm spectral range.

The 970-nm semiconductor diode lasers will be used for diode-pumping of the Cr:forsterite laser.

1. Generation and Amplification of Tunable Femtosecond Pulses

Continuous-wave mode-locked femtosecond Cr:forsterite oscillator and multikilohertz repetition-rate regenerative amplifier for generation and amplification of of tunable fs pulses were built. Standard 4-mirror astigmatically compensated laser cavity was constructed. The 20-W continuous-wave mode-locked Antares Nd:YAG laser from Coherent acquired using the funds under the AFOSR Research Instrumentation Program is being used to pump the Cr:forsterite femtosecond oscillator. The experimental setup is presented in Fig. 1.

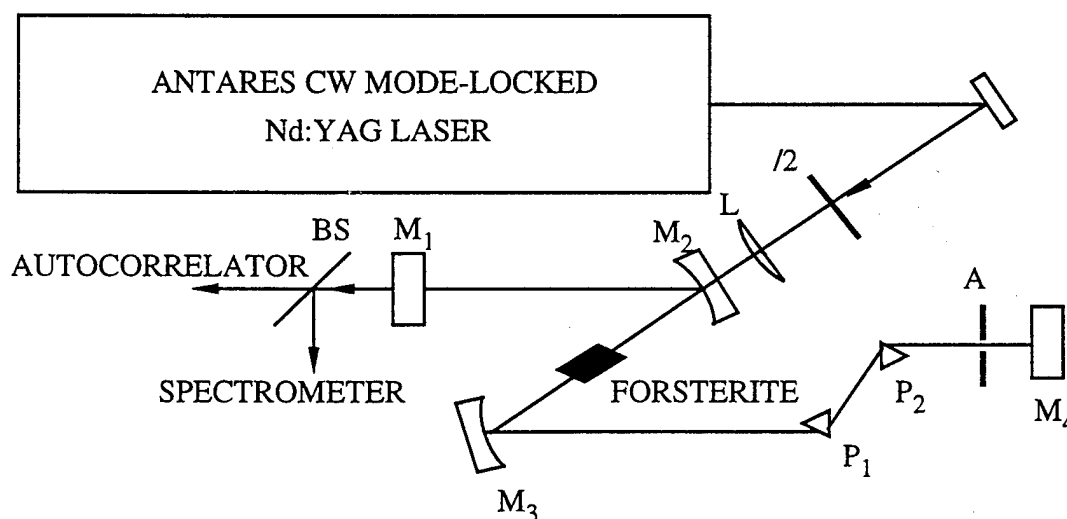


Figure 1. The femtosecond self-mode-locked Cr:forsterite laser with the ANTARES Nd:YAG mode-locked pump laser

The femtosecond pulses produced by forsterite oscillator are amplified using a regenerative amplifier. Regenerative amplification is based on multiple passes of a weak pulse through an inverted (pumped) gain medium. Once the gain is saturated, the amplified pulse is switched (dumped) out of the resonator cavity. Gains of several orders of magnitude can be achieved.

The Cr:forsterite regenerative amplifier, pulse stretcher, pulse compressor, and a Q-switched kHz Nd:YAG pump laser were custom built by Quantronix using the funds under the AFOSR Research Instrumentation Program. A schematic of the Cr:forsterite regenerative amplifier pumped by a Quantronix kHz Q-switched Nd:YAG laser is presented in Fig. 2.

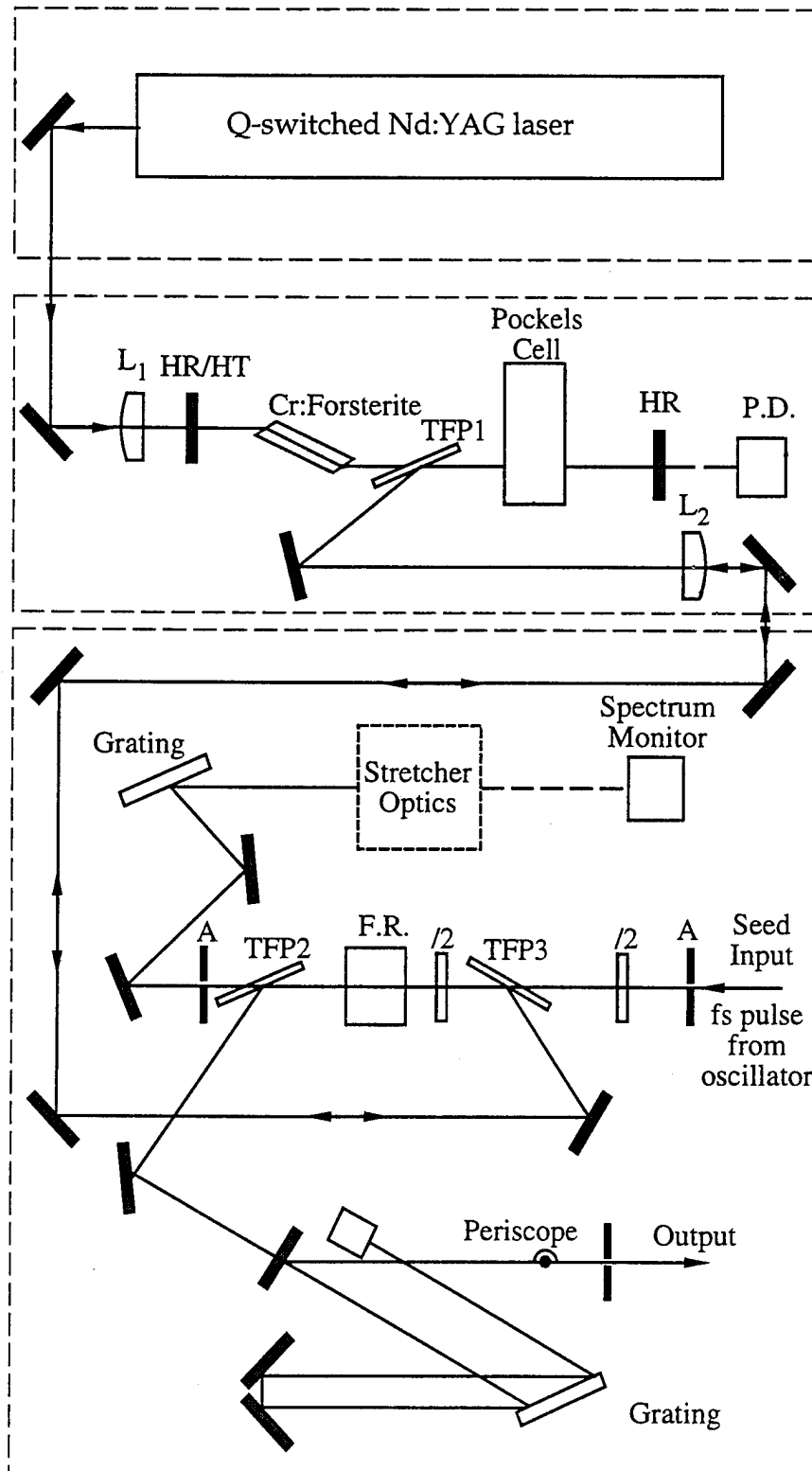


Figure 2. Cr:forsterite regenerative amplifier pumped by a Quantronix kHz Q-switched Nd:YAG laser. (TFP=Thin Film Polarizer, A=Aperture, FR=Faraday Rotator, PD=Photodetector)

2. Semiconductor Diode Pumped Solid-State Lasers

The diode-laser-pumped Cr:forsterite systems under development are shown schematically in Fig. 3. Two proposed cavity designs will be investigated: The three mirror resonator described in Figure 3 (a) requires anti-reflection and high reflection coating at the laser wavelength to be applied to either end of the Cr:forsterite crystal as well as an anti-reflection coating at the pump wavelength on the pump laser side of the crystal. This geometry allows two laser diodes to be used to pump the active medium. By using a four mirror resonator (detailed in Figure 3 (b)) the number of diodes utilized, and hence the pump power available is doubled. Four 1-W, 970-nm SDL 6360-C diode lasers and two 2-A drivers (SDL 800 M) were purchased from Spectra-Diode Lasers using the funds under the AFOSR Research Instrumentation Program for this purpose.

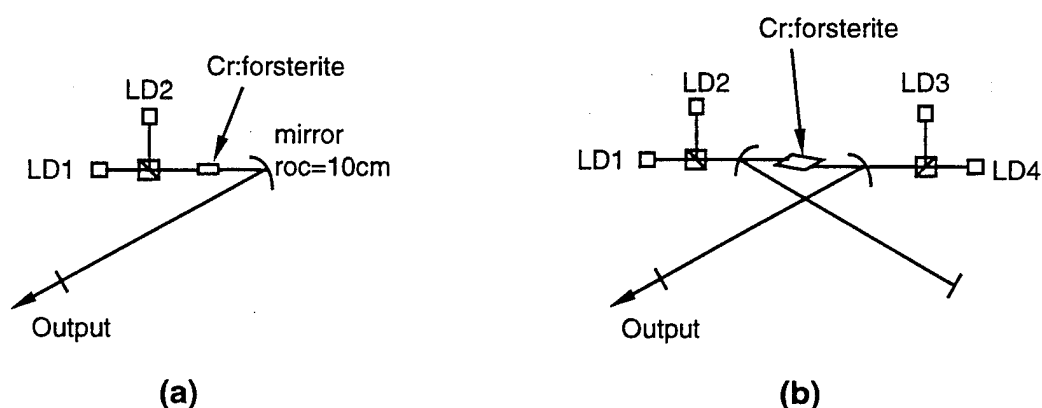


Figure 3. (a) Three mirror resonator and (b) four mirror resonator suitable for diode pumping investigations. LD1, LD2, LD3, and LD4 are 1-W, 970-nm SDL 6360-C diode lasers.

3. Gain-Switched Cr^{4+} :YAG Laser

The 1-kHz repetition rate continuously-pumped Q-switched Nd:YAG laser purchased under the AFOSR Research Instrumentation Program and previously mentioned in Fig. 2 was also used to pump a Cr^{4+} :YAG laser to generate over 150 mW 1-kHz tunable near-infrared laser pulses in the eye-safe 1.4 - 1.5 μm spectral region. The 1-kHz, Nd:YAG pumped Cr^{4+} :YAG laser is shown in Fig. 4.

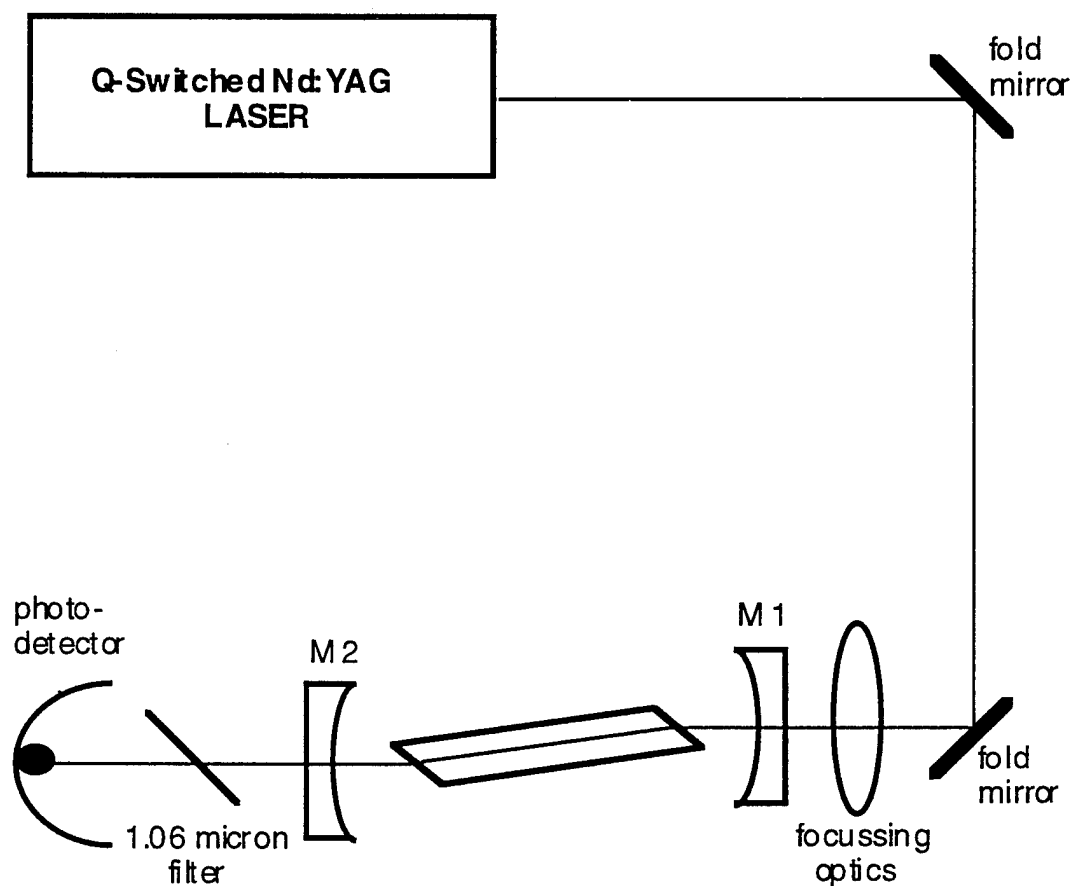


Fig. 4. 1-kHz, Nd:YAG pumped Cr^{4+} :YAG laser .